Laplace has considered the problem of the figure of the Moon in his *Théorie du Mouvement et de la figure elliptique des Planètes.* He takes into account the rotation of the Moon on its axis; but otherwise his solution is consistent with Frisi's result, and not with Newton's; see page 115 of the work. He does not mention either Newton or Frisi.

The Proposition to which this note relates is of no practical importance; but even in pure theory it is well to be accurate and consistent: I have therefore thought it would be useful to draw attention to a curious error which has indeed been corrected, but certainly not obliterated.

The Source of the Solar Heat. By Maxwell Hall, B.A.

Let us suppose that the mass of the Sun is slowly, but continually, contracting; then, in consequence of the enormous mass subjected to this contraction, an enormous amount of heat will be developed, and it will be found that the rate or amount of contraction necessary to produce the amount of heat radiated by the Sun into space, is so remarkably small, that ages must elapse before the effect of this contraction can become visible to us at our comparatively great distance from the Sun.

In order to show that this is the case, let one foot and one second be taken as the units of space and time, and suppose that each unit of volume of the Sun's mass contracts by the same amount in the same time, so that if z_0 be the linear contraction of the Sun's radius r_0 in one second, and if z be the contraction of any other length r, measured from the centre, and for the same duration of time, then $\frac{z}{z_0} = \frac{r}{r_0}$. The effect of this contraction may thus be compared to a series of intermittent pulsations, acting throughout the whole of the mass, and tending to diminish the volume. Let g_0 be the force of gravity at the surface of the Sun, and let g be the force of gravity at any point within the Sun's mass considered homogeneous, whose distance is r from the centre; then $\frac{g}{g_0} = \frac{r}{r_0}$. Again, let ϱ be the mean density of the Sun's mass, so that the weight of any thin concentric shell, whose radius is r and thickness ∂r, will be $4\,\pi g \varrho r^2 \partial r$; and, since every unit of mass in this shell falls through z feet towards the centre in a second of time, $4\,\pi g \varrho z r^2 \partial r$ will be the kinetic energy generated and destroyed every second by this shell alone; and therefore $\int_0^{r_0} 4\,\pi g z r^2 \, d r$ will be the whole kinetic energy destroyed every second of time, and we proceed to find the corresponding amount of heat evolved.

$$\text{Now} \int_0^{r_0} 4\,\pi\, g\, \varrho\, z\, r^2\, d\,r = \frac{4\,\pi\, g_0\, \varrho\, z_0}{r_0^{\,2}} \int_0^{r_0} r^4\, d\,r = \frac{4}{5}\,\pi\, g_0\, \varrho\, z_0\, r_0^{\,3},$$

and this is the kinetic energy destroyed by the fall of a weight $\frac{4}{5}\,\pi\, g_0\, \varrho\, r_0^{\,3}$ through a height of z_0 feet, or by the fall of a weight $\frac{4\,\pi\, g_0\, \varrho\, z_0\, r_0^{\,3}}{5 \times 1390}$ through a height of 1390 feet; but the fall of one pound avoirdupois through a height of 1390 feet generates sufficient heat to raise one pound of water through 1° centigrade, or it generates one thermal unit; hence by expressing $\frac{4\,\pi\, g_0\, \varrho\, z_0\, r_0^{\,3}}{5 \times 1390}$ in foot-pounds we shall get the number of thermal units generated every second of time. Now $g_0\, \varrho$ is the weight of a cubic foot of the Sun's mass at the surface, and since

$g_0 \;= 27{\cdot}20$ times the force of terrestrial gravity, and

$\varrho \;\;= 1{\cdot}43$ times the density of water, therefore

$g_0\, \varrho = 27{\cdot}20 \times 1{\cdot}43$ times the weight of a cubic foot of water at the surface of the Earth. But a cubic foot of water weighs 62·5 pounds, so that $g_0\, \varrho = 2431$ pounds.

Therefore $\frac{4\,\pi\, z_0\, r_0^{\,3} \times 2431}{5 \times 1390}$, when both r_0 and z_0 are expressed in feet, will give us the number of thermal units generated every second of time.

Now, it has been found by observation that the heat emitted by the Sun to the Earth is sufficient to melt a sheet of ice whose thickness is 0·01093 inches, when exposed perpendicularly to the Solar rays for one minute (Sir John Herschel, *Meteorology*), due allowance having been made for the heat absorbed by the atmosphere; and, therefore, in one second, a sheet of ice whose thickness is 0·0000152 feet will thus be melted; so that, if a be the mean distance of the Earth from the Sun, expressed in feet, a spherical shell of ice, whose radius is a and thickness 0·0000152 feet, will be the volume of ice in cubic feet melted every second by the whole of the radiant Solar heat. But one pound of ice has a volume equal to $(0{\cdot}2584)^3$ cubic feet, therefore $\frac{4\,\pi\, a^2 \times 0{\cdot}0000152}{(0{\cdot}2584)^3}$ will be the weight of the ice in pounds thus melted.

Again, in order to melt one pound of ice, 79·25 thermal units are required; and thus the whole Solar heat evolved in one second of time is equal to $\frac{4\,\pi\, a^2 \times 79{\cdot}25 \times 0{\cdot}0000152}{(0{\cdot}2584)^3}$ thermal units.

Now, by equating the heat generated to the heat evolved in one second, we get

$$\frac{4\,\pi\, z_0\, r_0^{\,3} \times 2431}{5 \times 1390} = \frac{4\,\pi\, a^2 \times 79{\cdot}29 \times 0{\cdot}0000152}{(0{\cdot}2584)^3},$$

and the contraction z_0 is therefore only 0·000004079 feet in one second, or 129 feet per annum; and, as we have already said, ages must elapse before the effect of this contraction can become

visible to us, whether we compare direct measures of the Solar disk or observed periods of axial rotation.

The contraction, therefore, is so small, that as much allowance can be made for the assumptions introduced above as may be thought necessary, without altering our general conclusion in the slightest degree, namely, that the source of the Solar heat and light is connected with the mechanical theory of heat by means of the contraction of the composing mass.

The application of this theory to other bodies is almost without limit; the Earth has contracted, and has stored up a corresponding amount of heat in the non-conducting rocks and soils; the stars, by their intrinsic brilliancy, indicate the operation of the force of gravity upon contracting matter; the nebulæ afford examples of the commencement of this operation; and periodical variations in light now become perturbations, the effect of disturbing masses in motion, producing endless changes subject to the great principle known as the conservation of energy.

January 1872.

On the Insufficiency of Existing National Observatories. By Lieut.-Col. A. Strange, F.R.S.

The Astronomer Royal, in a recent paper* on the "Proposed devotion of an Observatory to observation of the phenomena of Jupiter's Satellites," introduced his remarks in these words:—"The position which the Royal Astronomical Society holds in the astronomical world may well justify it in employing its judgment and its influence in the direction of astronomical enterprise exterior to its own body."

Adopting Mr. Airy's plea, I now propose to invite the attention of the Society to some further consideration of the question he has raised, as to the sufficiency of existing National Observatories.

These establishments were organised at a time when the objects of astronomical research were comparatively few, readily enumerated, and easily defined. The Royal Observatory was founded in the interests of navigation, and though that purpose has been very liberally interpreted, and much of the work done has had far higher aims, still, on the whole, it has been, for the most part, of a routine, observational character.

But within a comparatively recent period, the science of astronomy has made enormous advances in directions not contemplated when Greenwich was founded. And it has been for some time clear, that Greenwich cannot, as at present constituted, be expected to contribute systematically to the advancement of the new branch of astronomy to which I allude, namely, what is

* *Monthly Notices*, Jan. 12th, 1872, vol. xxxiii. No. 3.